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HORIZONS IN DAIRY PRODUCTION[1]

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The ascent of civilization has been described by the different ages such as the stone age, the iron age, the industrial age, the chemical age, and the atomic age. I do not feel that the use of the term "chemical" or "atomic" accurately describes the age of today. Actually, we are in the age of science, which implies research. I feel much like the preacher who was about to begin his Sunday sermon when he said, "Brothers and sisters, before I begin this sermon, I would like to say something." Like the preacher, I would like to say something--Progress and development in this age are dependent on research.

The purpose of this discussion today is to point up some of the changes in prospect which will take place in the future, insofar as dairy production is concerned. What are the thoughts in the minds of research workers today which may affect production tomorrow?

Historical Changes in Dairy Production

Before coming to the future, let us review briefly the past and the present situations, because they form a basis or gage of the future. Likewise, as a research worker with some 25 years of experience, I would like to justify my existence in the light of the problem of apparent over-production which we have with us today. Some have said that we should curtail production research to permit consumption to catch up with production.

Dairying has come a long way since the frontier days. The milk cow, along with the old dash churn, accompanied the settlers every step of the way in their settling of this country and their establishing farms. This was our first kind of dairying. Every family had a cow as a source of milk and butter. I am often peeved when I see a wagon train on the TV "Western" shows without the milk cow, because she was so much a part of the frontier days.

Following the days of the family cow, we had the development of the more specialized dairy farmer with the milk route. While crude at first, this type of dairying developed until it included processing and pasteurizing milk for home delivery. A few such large farm establishments are in operation today, but it is not the usual pattern of today.

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[1]Presented at Utah State University, August 8, 1958.

The pattern of today is for the dairy farmer to produce the raw product, milk, on the farm and deliver it to processing and bottling plants, which prepare and market the product. We are now changing from milk cans to bulk tanks.

This era of development has seen many changes take place on the farm, such as use of the milking machine, the Babcock test, and improved breeding, management, and feeding practices. During the past 10- to 15-year period, we have had a revolution in dairy farming which is still continuing. In 1944, we had 4 1/2 million farms with dairy cows. This number decreased to about 1 1/2 million farms in 1954. As a result, there has been an increase in the size of dairy farms and an increase in herd size. We have had a decrease in the size of the national dairy herd, an increase in production per cow, and an increase in total milk production. Thus, fewer farmers on larger farms, with fewer cows, are producing more milk now than in 1944.

The dairy industry has progressed from the frontier days of cow to consumer marketing to a complex industry involving an estimated 6.2 billion dollars per year when the value of calves and cattle used for meat is included. The dairy industry of today is the largest agricultural industry in the United States, as shown in the following tabulation:

1954 Value of Agricultural Products

	Billion dollars
Calves and cattle[1]	4.4
Sheep, lambs, and wool	0.16
Hogs	3.0
Chickens and turkeys	1.5
Eggs	1.9
Milk	4.8
79 Crops	18.3
Corn	4.2
Wheat	1.9
Cotton	2.4
Tobacco	1.2

[1]Includes dairy, estimated at 1.4 billion dollars.

Adapted from Agricultural Statistics 1956, USDA, pp.442-444, 447.

Nationally, the dairy industry ranks on an annual gross income basis with American Telephone and Telegraph, and U. S. Steel.

What Has Brought About These Changes?

These changes have been brought about through the use of technical information developed through research on feeding, breeding, and management. For example, through the advances of grassland farming, we have increased the quantity and improved the quality of forage which cows receive. Then too, we have learned improved feeding practices.

Breeding research has shown the way to increased production per cow by the use of proven sires in the artificial breeding associations. Management studies have altered housing and herd management practices.

Actually, much of the pressure for improvement was brought about during World War II because of the high demand for milk and the scarcity of dairy labor. At that time, industry could outbid the dairy farmer for labor. The dairy farmer has to improve his efficiency in order to survive.

The following tabulation shows that in 1830, the average farm worker produced enough food and fiber for himself and 3 others. A century later, he produced enough for himself and 9 others, and by 1955 he was producing enough for himself and 20 others.

Year	Persons supported by one farm worker
1830	4.0
1920	8.3
1930	9.7
1940	10.7
1950	15.5
1955	19.8

Data from Changes in Farm Production Efficiency, ARS 43-55, ARS, USDA.

In some undeveloped countries practically all the people live on farms. They all have to farm in order to survive because of low efficiency of production. It has been said that we have made more progress in agriculture in the last 50 years in the United States than the world had made in 50 centuries. I feel that agricultural scientists can be justly proud of this record.

The fact that less manpower is required to produce the food and fiber needs of our country and more manpower is therefore made available to industry, is the main reason for our present economic and industrial strength in the world of today. The manpower released now builds automobiles, TV sets, airplanes, houses, and many other items that

give us the highest standard of living of any country in the world.

The efficiency of production of the dairy farmer has paralleled that for all farm production. Yet, since World War II, dairy farmers have not kept pace with poultry and crop production efficiency. Even so, today we hear of goals of production of 100,000 to 400,000 lb. of milk per year for each unit of labor on the farm. In New Zealand, a goal of 200,000 lb. is discussed. A level of production of 100,000 lb. of milk per year per unit of labor would furnish enough energy for about 27 people for 1 year.

Some Economic Aspects of Dairy Production

To complete the picture of today, we must consider some complex economic aspects of dairying, in as simple terms as we can.

The competition in dairy farming today is a cut-throat business. Each farmer is in competition with his neighbor, area against area and State against State. Many of the cotton farmers of yesterday in the Southeastern United States are learning to be dairymen today. They have lost the cotton crop to the irrigated West. As they learn and become more efficient, which is a long process, other dairy areas or States can expect competition for markets from the Southeastern States. In the southeastern area, where the pasture and growing seasons are longer and where housing requirements are minimal, we can expect that this competition will become very real in the future.

The milk which the dairy farmer produces today is also in competition with other foods for the consumer's dollar. Milk as a food is as good a buy as it was in 1930, according to information from the Department of Labor, shown in the following tabulation on page 5.

Milk delivered to the kitchen of the average production worker in 1925 cost 14 cents per quart on the average. In 1957, it cost 25 cents per quart. Yet in 1925, the average production worker had to work for 15 minutes to pay for 1 quart of milk and only 7 minutes in 1957. In terms of labor spent, the average worker is getting milk 50% cheaper than in 1925. Other food products follow much the same pattern.

Despite the fact that milk is still an excellent food buy, our level of consumption has decreased considerably since the war years; this is in part due to a decrease in butter consumption. The program of the American Dairy Association is working to reverse this trend. We are not the top consumers of milk products in comparison to some other countries. I believe we have considerable room for expansion of our home markets.

Work Time Required to Purchase Specified Foods

Food	Quantity	Work Time in Minutes[1]						
		1890	1925	1930	1940	1950	1957	1957 as percent of 1925
Bread	lb.	19	10	9	7	6	5	50
Round steak	lb.	46	39	46	33	38	27	69
Butter	lb.	95	60	50	33	30	22	44
Potatoes	5 lb.	30	20	20	11	9	8	40
Sugar	lb.	26	8	7	5	4	3	38
Milk, del.	qt.	26	15	15	12	8	7	47
Eggs	doz.	78	60	48	30	25	17	28

		Annual Average Retail Prices[2]						
Bread	lb.	$0.05	$0.09	$0.09	$0.08	$0.14	$0.19	211
Round steak	lb.	12	.36	.43	.36	.94	.94	261
Butter	lb.	26	.55	.46	.36	.73	.74	134
Potatoes	5 lb.	08	.18	.18	.12	.23	.29	161
Sugar	lb.	07	.07	.06	.05	.10	.11	157
Milk, del.	qt.	07	.14	.14	.13	.21	.25	179
Eggs	doz.	21	.55	.45	.33	.60	.57	104

[1]Based on average hourly earnings, including overtime, of production workers in manufacturing industries.
[2]Average retail food prices published annually in Retail Food Prices by Cities.

Data from Bureau of Labor Statistics, U. S. Department of Labor.

I have been told that there is a surplus of milk in Japan despite the fact that the average Japanese[2] consumed only 4.5 lb. of milk and its products per year in 1949. This is partially due to the high cost of milk in comparison to other foods, possibly owing to production inefficiency.

Despite the fact that milk is still as good a buy as other foodstuffs on the market today, perhaps better, one can hardly escape the thought that decreased consumption of milk and its products is due in part to increased costs in the kitchen. This is only a feeling which is difficult to document. Economic studies have shown that, other things being equal, a 10% decrease in the price of milk will increase consumption by 3 to 5%, and conversely a 10% increase in price will decrease

[2]Nutrition News, National Dairy Council, Vol. 14: 13 (1951).

The following tabulation compares the consumption of dairy products in nine countries:

Consumption of Dairy Products per Capita

Country	Year	Milk & cream	Butter	Cheese	Condensed & evaporated	Ice cream	Total
		Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
United States	1945	399	10.8	6.6	18.0	15.5	777
United States	1955	353	8.9	7.8	16.0	17.7	707
Belgium	"		24.1	11.3	5.3		983
Denmark	"		18.7	14.6	Neg.		854
France	"		14.8	16.7	1.8		736
Netherlands	"		6.5	15.8	7.9		658
Sweden	"		24.0	16.8	0.6		1,131
New Zealand	"		44.9	6.1	8.0 + DM		1,353
Ireland	"		43.7	16.0	Not av.		1,489
U. K.	"		14.7	9.4	6.0		753

Data from Dairy Statistics, Statistical Bulletin 218, Agr. Mktg. Service, USDA.

consumption by 3 to 5%[3]. Increased costs are due to many factors. Processing costs have increased some. During World War II, the processor received 45 cents and the producer 55 cents out of every dollar spent for dairy products. Today, the portion of the dollar going into processing and marketing has increased considerably so that the processor receives 55 cents and the producer 45 cents out of every dollar spent for dairy products.

This brings me to the crux of a serious question I should like to pose to you. Let us suppose that there had been no new scientific information developed since 1920, and we had to produce milk with the average 1920 model cow producing 4,000 lb. milk/yr. at present costs for labor, feed, and capital investment. Where would dairying be today? It would be my best "guesstimate" that milk would cost at least one-third to one-half more to produce on the farm. I would say that dairying would rapidly fade away, because the price the farmer would have to receive for his milk to stay in business would be exorbitant, and we would have a more serious milk surplus problem than we have today.

It is with this thought that I justify my existence as an agricultural scientist and maintain that the only salvation of any competitive industry is efficient production. If we are not efficient, we will lose our market. We must continue to seek for improved methods of production.

[3]Tech. Bul. 1168, Agr. Mktg. Serv., USDA

New Information More Difficult to Obtain

You should be aware of one more sobering thought. New research information in the future will be more difficult and expensive to obtain. New information can only be obtained, by better trained scientists, through the use of more animals, more expensive scientific laboratory gadgetry, and a longer period of years.

We should also bear in mind that our practical research on dairy production problems during the past 50 years has been based on the discovery of fundamental principles. In order to advance our practical knowledge further for efficient production, we must increase and intensify our efforts on basic research. The time lag between the discovery of basic principles and their practical application on the farm sometimes requires as much as 25 years.

Let us not be lulled to sleep with the thought that we should curtail our production research. True, research on utilization and marketing are greatly needed to supplement and keep step with production research.

Present Horizons

The possibilities for improvement in dairy production that are showing over the horizon today are breathtaking. The greatest opportunity for increasing production per cow will be through genetic improvement by the use of proven sires through the artificial breeding associations. Improvement through the use of proven sires does not take place overnight. It takes years with no mistakes. It is certainly well established from DHIA data that the high-producing cow is the most efficient and most profitable cow in the herd. In 1957, data from herds in the DHIA program, that used proven sires from the artificial breeding associations, showed that the daughters produced 678 lb. more milk and 37 lb. more fat than their respective dams. Today, 27% of our U.S. dairy cow herd are being artificially inseminated. With present techniques, it is possible for an AB bull to sire as many as 20,000 progeny each year and more than 100,000 in a lifetime. Improvement pressure will increase as the use of proven sires increases.

The development of techniques for freezing and storing semen is one of the great advances of the past 10-year period. It is possible to utilize the semen produced by a superior sire more efficiently than in the past. It may be possible to produce offspring of a sire long after he is dead. Thus, we can see that the use of frozen semen will spread the use of superior germ plasm and will have a tremendous impact upon dairy production in the years to come.

To my knowledge, the best example that has definitely demonstrated the use of proven sires consists of the results obtained from the proven sire project at Beltsville, Maryland. This Holstein herd increased

from 540 lb. in fat production to about 700 lb. of fat on a 2 x 305 ME equivalent basis. This improvement required 25 years to bring about. Last year, the herd of 44 cows on AR Test led the honor list on the achievement recognition program sponsored by the Holstein Friesian World. As I indicated before, it takes patience and forethought to develop a high producing herd.

However, some evidence in the proven-sire experiment at Beltsville indicates that we may have reached a ceiling at this level of production. Can this ceiling be pushed up? The answer to this question will have to await further scientific developments and, as I have indicated previously, the answer will be difficult to obtain.

One of the tools available today to provide information for more efficient production on the farm is the use of the DHIA Testing Program. Three forms of testing are available: (1) The Standard DHIA Test; (2) The Owner Sampler Program; and (3) The WADAM Program. Only about 10% of the United States dairy herd is on one of the DHIA Testing Programs. In New Zealand where efficient production is stressed, I found 50% of the cows being tested. I believe this is one service a dairy farmer can ill afford to be without. It permits culling out low producers and aids in the breeding, feeding, and management of the herd. Nationally, it provides a means of locating proven sires in farm herds.

The present development in the States or regions of automated electronic procedures for data processing will in the future make this program more attractive and workable.

The improvements that may be made genetically are not attainable without good feeding and management. The present horizons in feeding can be reached through application of a good grassland program. Good pasture for the summer and high quality, properly preserved forage for winter feeding are the backbone of the economical production of milk. Both are attainable today through the use of high producing grasses and legumes or their combination, coupled with good fertilizer practices. Research on pastures has shown that production can be increased from 3,000 lb. of milk per acre to 8,000 to 9,000 lb. of milk per acre. Twelve-thousand pounds are highly probable. While harvesting procedures today are not completely perfected, good quality, highly nutritious forages for winter feeding can be had today by careful planning.

Future Horizons

What are the problems the dairy scientists of today are cogitating and attacking which could lower the horizons of tomorrow and that might well change or alter dairy production? Whether all the objectives or ideas will prove fruitful must remain for the future to judge.

One intriguing problem stirring in the brains of some of our agricultural scientists concerns the efficiency of forage utilization. Do cows vary in the efficiency of utilization of forage nutrients and does the characteristic have a genetic basis? Some experiments at Beltsville have shown that individual cows vary as much as 15% in the amount of alfalfa hay required to maintain body weight. A further statistical analysis of data collected in the proven-sire project has shown that there are differences between sire groups in the efficiency with which the daughters utilize feed nutrients to produce milk. Further experiments in cooperation with a few States are in progress to obtain more information. Perhaps we can breed cows that will utilize forage more efficiently than the average cow of today.

With the increased interest in the solids-not-fat (SNF) fraction of milk, dairy scientists are attempting to determine whether this characteristic has a genetic basis. Can we breed cows that will produce a higher SNF than the present average cow? The SNF contains the protein, sugar, minerals, and vitamins, or all the constituents other than fat. These are the most important nutrients in the human diet.

Some in the nutrition and medical field have proposed that fat intake has some effect on cholesterol deposition in tissues, which may perhaps result in the pathological changes which take place in the blood vascular system of man. This concerns the development of heart disease, which we hear so much about today. This thinking, and the publicity it has received during the past few years, has caused the public to be hesitant about the consumption of fats in the diet, including the fat in milk. The full answer to this problem is not available at this time. In any event, the dairy industry can use any facts it can gather on the extent to which the composition of milk can be altered through use of genetic principles.

Some preliminary data indicate that the SNF fraction of milk may be a heritable character. A kit for the rapid determination of SNF in milk has been developed at Beltsville and will soon be available for widespread use. Various States are developing a cooperative project to obtain some of the needed answers. Perhaps we can tailor the composition of milk more to the needs and demands of the public.

Other breeding projects are in the minds of dairy scientists, such as the development of cattle adapted to the heat of the South, to mastitis resistance, and to longevity. Projects to develop information or genetic principles of inheritance for milk production are in progress or are being formulated. Does rate of milk letdown have a genetic basis? This, of course, affects the time required to milk the herd. Further information on the effects of cross-breeding is being sought. There is so much to do in breeding research, and thank goodness so many ideas, that dairy scientists will have no time for loafing for 100 years.

The look over the horizon into the new developments that are possible in the feeding of the dairy herd are exciting. For instance, at Beltsville we have been studying the fundamental bacteriological and chemical changes that take place in silage making. We now know the sequence of development of different types of bacteria in silage. We know that the bacteria through fermentation produce the various organic acids, such as lactic and acetic acids which preserve the silage. We know that the sequence of changes can be altered and the quality of the silage can be affected by changing the environment in which the bacteria grow, such as the amount of inclusion or exclusion of air. Through these basic studies we have learned that different cuttings and different crops differ in their ability to make a good quality silage. This may be due to differences in chemical composition of the original crop before ensiling. Is it possible that this composition might be influenced by the fertilizer practices used, or is it even possible that if we knew the factors involved we could breed plants which always contained the factors necessary to make a good quality silage? Such basic knowledge may well lead to a breakthrough in silage making to make high quality feed.

Today, many laboratories are seeking out the mysteries of digestion in the rumen of cattle. The kinds of bacteria involved and their effects on feed nutrients are being probed. The chemical changes that take place in the rumen as a result of bacterial action are being elucidated. While few practical results have come thus far from such studies, it is not impossible that we may yet learn something of very practical value. The mysteries surrounding bloat and ketosis may well be answered by such basic research.

A new energy-metabolism laboratory has just been placed in operation at Beltsville for use with dairy cattle. The purpose of the laboratory is to evaluate forages and to explore basic principles of metabolism of the dairy cow. At the same time that forages are being evaluated on an energy basis, detailed chemical analysis of the forages fed will be made. In the end, we hope that chemical methods will be developed which will predict the true nutritive value of forages. Also, in the end we hope to develop improved standards for expressing the basic requirements of dairy cattle and an improved nomenclature for expressing the productive value of feeds.

In connection with the energy laboratory, we are developing techniques for measuring the energy metabolism of grazing animals. We feel, at the present time, that our present values used for the maintenance of a grazing animal are too low and cause considerable error in the evaluation of pastures. If this becomes a demonstrated fact, such information could lead to a more accurate evaluation of pastures.

What are the factors which cause one forage to be consumed in larger quantities than another? Improved methods of forage preservation such as pelleting from the field, improved pasture species, and improved management are in the minds of our research people. Much still remains to be learned.

In the area of the physiology of the dairy cow, we have barely scraped the surface. We know that hormones control the level of milk production. If we understood the relationships of all the hormones to each other and to the animal concerned, could we make a poor-producing cow a good producer by the use of hormone therapy? This is a very exciting thought.

In the area of reproduction, more basic information is needed. Infertility in dairy cattle is costly to the dairy farmer, and yet we have little information we can give to the dairy farmer today to overcome this difficulty. We are going to have to dig deeper - much deeper into the intricacies of normal reproduction before we can hope to come up with the answers.

Other challenging problems in the area of physiology, such as control of sex and ova transplantation, are in the minds of research workers.

Research in progress at the University of Minnesota indicates that it may be possible to produce milk which may aid in the control of disease through the development of antibodies in the milk. For instance, it might be possible to control hay fever through consumption of a special milk. Such an advancement would make possible the sale of a special-purpose milk.

The future horizons in the National Dairy Herd Improvement Program of the Dairy Cattle Research Branch are bright at this time. The programming for automatic data processing is going on at the present time with the hope that the program will be in operation within the coming year. In this program, data are recorded on tape similar to that used in recording sound, such as music. The tapes are then run through electronic calculating machines which will make thousands of calculations per minute and which will then print out the answers. Such equipment is the same as that used in calculating the speed and orbit of Sputnik and Explorer satellites. With such automatic mechanization, the Branch will be able to keep up to date the data on bull proofs. Similarily, we hope to be able to expand the program to include a broader program of research on the many factors associated with sire proving. We are not taking advantage of the research possibilities of these data at the present time.

In considering the horizons of the future in dairy production, there is one in the processing field which may produce marked changes in the farming areas where milk will be produced in the future. I refer to recent developments in the processing and packaging of milk. In this connection, I have learned that the meaning of the letters H.T.S.T. is "high-temperature short-time sterilization." Milk may be sterilized, for example, at a temperature of 285° F. for 15 seconds or its equivalent, concentrated, and canned aseptically to produce milk which, when reconstituted, has a nearly normal flavor.

The application of high-temperature, short-time sterilization may prove to be applicable as well to partially concentrated or to whole milk. The problems of gelation, flavor, and so forth, which have held such developments in abeyance for years, appear to be yielding to the application of fundamental chemistry. Concomitantly, such fundamental studies may well solve the problem of producing a dried milk powder which, when reconstituted, will retain the characteristics of fresh milk.

However, let us dwell on the impact of these research findings upon our industry. On this, there are considerable differences in opinion. The conservative scientists point out the possibility of supplying milk to isolated areas and to the Armed Forces in any part of the world. The less conservative point out that owing to longer shelf life of these products the midwestern farmer, for instance, will be brought into competition with the farmer in our eastern milkshed area. Artificial barriers to the movement of milk now common in some areas may become a matter of history. Further, the impact may carry so far as to affect the methods of milk distribution to the housewife.

Before closing, it is only proper to call attention to the future horizons in other areas which will have their effect on dairy production. Plant breeders are bound to develop better adapted, more nutritious, and more disease-resistant strains of grasses and legumes to feed our national dairy herd. Scientists working in the area of animal diseases will undoubtedly develop methods and techniques to meet the scourge of cattle diseases. Entomologists are busy at work developing techniques to destroy insects harmful to livestock and to plants on which livestock feed. These developments and many others will contribute greatly toward efficient dairy production.

The final research objective is to produce research results to provide information to permit the dairy farmer to produce the greatest output of milk per cow per unit of feed input, per acre of land farmed, per unit of labor expended.

With the knowledge of future developments, I have no fear that the dairy industry has anything but a bright future. We have good products which are nutritious and palatable to the taste of our people.

We should give thanks that we have an active dynamic research program on which to base our future development.